

What is Claimed:

1 1. A terahertz (THz) frequency radiation source to emit THz
2 frequency radiation in a narrow wavelength band within a wavelength range of about
3 3 μm to 3000 μm comprising:

4 a broad bandwidth THz frequency emitter to generate broad bandwidth
5 THz frequency radiation in an emitted wavelength band within the wavelength range,
6 the emitted wavelength band having;

7 a mid-band wavelength within the emitted wavelength band;
8 and

9 an emitted bandwidth greater than or equal to about .01 times
10 the mid-band wavelength;

11 a first planar waveguide optically coupled to the broad bandwidth THz
12 frequency emitter to transmit the broad bandwidth THz frequency radiation;

13 a disk resonator evanescently coupled to the first planar waveguide
14 with a resonance wavelength band within the emitted wavelength band, the
15 resonance wavelength band having a resonance wavelength bandwidth of less than
16 or equal to about .25 times the emitted bandwidth; and

17 a second planar waveguide evanescently coupled to the disk resonator
18 to transmit THz frequency radiation in the narrow wavelength band, the narrow
19 wavelength band being substantially equal to the resonance wavelength band of the
20 disk resonator.

1 2. The THz frequency radiation source of claim 1, wherein the
2 broad bandwidth THz frequency emitter is one of:

3 a silicon/silicon-germanium quantum well structure intersubband
4 electroluminescence emitter;

5 a resonant state transition emitter;

6 a non-quantum well, doped group IV material emitter;

7 a blackbody radiation source; or

8 an incandescent radiation source.

1 3. The THz frequency radiation source of claim 1, wherein:

2 the first planar waveguide includes;

3 a first waveguide portion having a substantially rectangular
4 cross-section and a bottom surface, the first waveguide portion formed of a
5 waveguiding material, the waveguiding material being substantially
6 transmissive in the emitted wavelength band and having a waveguide index
7 of refraction; and

8 a first pedestal portion connecting a central portion of the
9 bottom surface of the first waveguide portion to a substrate;

10 the disk resonator includes;

11 a resonator portion having a substantially cylindrical shape and
12 a bottom surface, the resonator portion formed of the waveguiding material;
13 and

14 a resonator pedestal portion connecting a central portion of the
15 bottom surface of the resonator portion to the substrate; and

16 the second planar waveguide includes;

17 a second waveguide portion having a substantially rectangular
18 cross-section and a bottom surface, the second waveguide portion formed of
19 the waveguiding material; and

20 a second pedestal portion connecting a central portion of the
21 bottom surface of the second waveguide portion to the substrate.

1 4. The THz frequency radiation source of claim 3, wherein the
2 waveguiding material is a substantially undoped material formed of one or more
3 group IV elements.

1 5. The THz frequency radiation source of claim 4, wherein the
2 substantially undoped material formed of one or more group IV elements includes at
3 least one of:

- 4 a crystalline material formed of one group IV element;
- 5 a crystalline material formed of an alloy of group IV elements;
- 6 an amorphous material formed of one group IV element;
- 7 an amorphous material formed of an alloy of group IV elements;
- 8 an amorphous crystalline material formed of one group IV element;
- 9 an amorphous crystalline material formed of an alloy of group IV
10 elements;
- 11 a polycrystalline material formed of one IV element; or
- 12 a polycrystalline material formed of an alloy of group IV elements.

1 6. The THz frequency radiation source of claim 4, wherein the
2 substantially undoped material formed of one or more group IV elements is selected
3 from a group consisting of: diamond, crystalline silicon, crystalline germanium,
4 crystalline silicon carbide, crystalline silicon germanium, polycrystalline silicon,
5 amorphous diamond, amorphous silicon, and amorphous germanium.

1 7. The THz frequency radiation source of claim 3, wherein:

2 the first pedestal portion of the first planar waveguide is formed of the
3 waveguiding material;

4 the resonator pedestal portion of the disk resonator is formed of the
5 waveguiding material;

6 the second pedestal portion of the second planar waveguide is formed
7 of the waveguiding material; and

8 the substrate is formed of the waveguiding material.

1 8. The THz frequency radiation source of claim 3, wherein:

2 the first pedestal portion of the first planar waveguide is formed of a
3 pedestal material, the pedestal material having a pedestal index of refraction, the
4 pedestal index of refraction being less than the waveguide index of refraction; and

5 the resonator pedestal portion of the disk resonator is formed of the
6 pedestal material; and

7 the second pedestal portion of the second planar waveguide is formed
8 of the pedestal material.

1 9. The THz frequency radiation source of claim 1, wherein the
2 mid-band wavelength within the emitted wavelength band is a peak wavelength of
3 the emitted wavelength band.

1 10. The THz frequency radiation source of claim 1, wherein the
2 emitted wavelength band includes wavelengths within the wavelength range for
3 which the broad bandwidth THz frequency emitter generates an emitted spectral
4 power greater than a predetermined spectral power.

1 11. The THz frequency radiation source of claim 1, further
2 comprising:

3 an additional disk resonator evanescently coupled to the first planar
4 waveguide with an additional resonance wavelength band within the emitted
5 wavelength band, the additional resonance wavelength band;

6 having an additional resonance wavelength bandwidth of less
7 than or equal to about .25 times the emitted bandwidth; and

8 being distinct from the resonance wavelength band; and

9 a third planar waveguide evanescently coupled to the additional disk
10 resonator to transmit THz frequency radiation in the additional resonance wavelength
11 band of the additional disk resonator.

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1 12. A terahertz (THz) frequency radiation detector to detect a
2 narrow wavelength band of THz frequency radiation within a wavelength range of
3 about 3 μm to 3000 μm , comprising:

4 a broad bandwidth THz frequency radiation detector with a detection
5 wavelength band within the wavelength range, the detection wavelength band
6 having;

7 a shortest detected wavelength within the detection wavelength
8 band; and

9 a detection bandwidth greater than or equal to about .01 times
10 the shortest detected wavelength; and

11 a narrow bandwidth THz frequency band wavelength selector coupled
12 to the broad bandwidth THz frequency radiation detector to select and transmit only
13 THz frequency radiation in the narrow wavelength band to the broad bandwidth THz
14 frequency radiation detector, the narrow bandwidth THz frequency band wavelength
15 selector including;

16 a first planar waveguide optically to receive input radiation;

17 a disk resonator evanescently coupled to the first planar
18 waveguide with a resonance wavelength band within the detection
19 wavelength band, the resonance wavelength band having a resonance
20 wavelength bandwidth of less than or equal to about .25 times the detection
21 wavelength bandwidth; and

22 a second planar waveguide evanescently coupled to the disk
23 resonator and optically coupled to the broad bandwidth THz frequency
24 radiation detector to transmit the narrow wavelength band of THz frequency
25 radiation from the disk resonator to the broad bandwidth THz frequency
26 radiation detector, the narrow wavelength band being substantially equal to
27 the resonance wavelength band of the disk resonator.

1 13. The THz frequency radiation detector of claim 12, wherein the
2 broad bandwidth THz frequency radiation detector is one of:

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a silicon/silicon-germanium quantum well structure detector;
a resonant state transition detector;
a non-quantum well, doped group IV material detector; or
a bolometer.

14. The THz frequency radiation detector of claim 12, wherein:

the first planar waveguide includes;

a first waveguide portion having a substantially rectangular cross-section and a bottom surface, the first waveguide portion formed of a waveguiding material, the waveguiding material being substantially transmissive in the narrow wavelength band and having a waveguide index of refraction; and

a first pedestal portion connecting a central portion of the bottom surface of the first waveguide portion to a substrate;

the disk resonator includes;

a resonator portion having a substantially cylindrical shape and a bottom surface, the resonator portion formed of the waveguiding material; and

a resonator pedestal portion connecting a central portion of the bottom surface of the resonator portion to the substrate; and

the second planar waveguide includes;

a second waveguide portion having a substantially rectangular cross-section and a bottom surface, the second waveguide portion formed of the waveguiding material; and

a second pedestal portion connecting a central portion of the bottom surface of the second waveguide portion to the substrate.

1 15. The THz frequency radiation detector of claim 14, wherein the
2 waveguiding material is a substantially undoped material formed of one or more
3 group IV elements.

1 16. The THz frequency radiation detector of claim 15, wherein the
2 substantially undoped material formed of one or more group IV elements includes at
3 least one of:

4 a crystalline material formed of one group IV element;

5 a crystalline material formed of an alloy of group IV elements;

6 an amorphous material formed of one group IV element;

7 an amorphous material formed of an alloy of group IV elements;

8 an amorphous crystalline material formed of one group IV element;

9 an amorphous crystalline material formed of an alloy of group IV
10 elements;

11 a polycrystalline material formed of one IV element; or

12 a polycrystalline material formed of an alloy of group IV elements.

1 17. The THz frequency radiation detector of claim 15, wherein the
2 substantially undoped material formed of one or more group IV elements is selected
3 from a group consisting of: diamond, crystalline silicon, crystalline germanium,
4 crystalline silicon carbide, crystalline silicon germanium, polycrystalline silicon,
5 amorphous diamond, amorphous silicon, and amorphous germanium.

1 18. The THz frequency radiation detector of claim 14, wherein:

2 the first pedestal portion of the first planar waveguide is formed of the
3 waveguiding material;

4 the resonator pedestal portion of the disk resonator is formed of the
5 waveguiding material;

6 the second pedestal portion of the second planar waveguide is formed
7 of the waveguiding material; and

8 the substrate is formed of the waveguiding material.

1 19. The THz frequency radiation detector of claim 14, wherein:

2 the first pedestal portion of the first planar waveguide is formed of a
3 pedestal material, the pedestal material having a pedestal index of refraction, the
4 pedestal index of refraction being less than the waveguide index of refraction; and

5 the resonator pedestal portion of the disk resonator is formed of the
6 pedestal material; and

7 the second pedestal portion of the second planar waveguide is formed
8 of the pedestal material.

1 20. The THz frequency radiation detector of claim 12, wherein the
2 detection wavelength band includes wavelengths within the wavelength range for
3 which the broad bandwidth THz frequency radiation detector detects radiation having
4 a spectral power greater than a predetermined spectral power.

1 21. The THz frequency radiation detector of claim 12, further
2 comprising:

3 an additional broad bandwidth THz frequency radiation detector with
4 an additional detection wavelength band within the wavelength range, the additional
5 detection wavelength band having;

6 an additional shortest detected wavelength within the detection
7 wavelength band; and

8 an additional detection bandwidth greater than or equal to
9 about .01 times the additional shortest detected wavelength; and

10 wherein;

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11 the narrow bandwidth THz frequency band wavelength selector
12 is further coupled to the additional broad bandwidth THz frequency radiation
13 detector to select and transmit only THz frequency radiation in an additional
14 narrow wavelength band to the additional broad bandwidth THz frequency
15 radiation detector; and

16 the narrow bandwidth THz frequency band wavelength selector
17 further includes;

18 an additional disk resonator evanescently coupled to the
19 first planar waveguide with an additional resonance wavelength band
20 within the detection wavelength band, the additional resonance
21 wavelength band;

22 having an additional resonance wavelength
23 bandwidth of less than or equal to about .25 times the
24 additional detection wavelength bandwidth; and

25 being distinct from the resonance wavelength
26 band; and

27 a third planar waveguide evanescently coupled to the
28 additional disk resonator and optically coupled to the additional broad
29 bandwidth THz frequency radiation detector to transmit the additional
30 resonance wavelength band of THz frequency radiation from the
31 additional disk resonator to the additional broad bandwidth THz
32 frequency radiation detector.